VOL. 21 NO. 3 SEPTEMBER, 1950

COMMONWEALTH INST. ENTOMOLOGY LIBRARY
30 OCT 1951
SERIAL Aus.20
SEPARATE

Priority

COLONY OF FIJI

AGRICULTURAL JOURNAL

ISSUED BY THE

DEPARTMENT OF AGRICULTURE, FIJI

PRICE : THREE SHILLINGS.

GOVERNMENT PRESS, SUVA, FIJI

~~[1951]~~

Notes for Libraries and Research Institutes.

FORMER ISSUES OF AGRICULTURAL JOURNAL.

So many requests are received from abroad for parts of the *Agricultural Journal* which were never published that the following list of all issues published and those which are not now available is given for reference. Attention is especially directed to Volume 7 which had only one part:—

Vol.				*Vol.*			
1.	3	numbers,	1928.	11.	4	numbers,	1940 (none).
2.	4	,,	1929.	12.	4	,,	1941 (none of Nos. 1 and 2).
3.	3	,,	1930 (none).				
4.	4	,,	1931.	13.	4	,,	1942.
5.	2	,,	1932 (none of No. 2).	14.	4	,,	1943.
6.	2	,,	1933.	15.	4	,,	1944.
7.	1	,,	1934.	16.	4	,,	1945.
8.	4	,,	1935–37 (none of No. 4).	17.	4	,,	1946 (none of No. 1).
9.	4	,,	1938 (none of Nos. 2, 3 and 4).	18.	4	,,	1947 (none of No. 1).
				19.	4	,,	1948 (Nos. 3 & 4 form a double issue.)
10.	4	,,	1939 (none of Nos. 2 and 4).	20.	4	,,	1949.

ISSUES OF THE AGRICULTURAL CIRCULAR.

NUMBERS and year of issue of the *Agricultural Circular* :—

Vol. 1, 1920, 12 numbers.
2, 1921, 5 ,,
3, 1922, 4 ,,
Vol. 4, 1923, 1 number.
5, 1924–5, 2 numbers.

As number 4 of Vol. 3 was printed as " Volume 4 " and number 1 of Vol. 4 as " Volume 5 " it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

ANNUAL BULLETINS.

THE Annual Bulletin of Divisional Reports ran from 1931 to 1938 and was then discontinued.

OLD ISSUES OF AGRICULTURAL BULLETINS.

FREE copies of the following Bulletins are available to Colonial Departments of Agriculture research institutes and bona fide planters within the Colony.

No. 1. Sisal Hemp in Fiji, 1911.
3. Rhinoceros Beetle in Samoa, 1912.
4. The Banana in Fiji, 1912.
5. Scale Insect on Bananas, 1913.
6. Lemon Grass, 1913.
7. A Mission to Java for a Coleopterous Pest of Bananas, 1914.
8. Coconut Experiments, 1915.
9. Soils of Fiji—I, 1916.
11. Alluvial Soils of Fiji, 1918.
12. Leaf Moth of Coconuts, 1919.
13. Sea Island Cotton, 1920.
14. Transparent Coconut Scale, 1921.
15. Purple Leaf Moth of Coconuts, 1924.
18. Control of Coconut Spike Moth, 1935.

The following are available to the public at the prices shown—

No. 21. Biological Control of the Rhinoceros Beetle, 1941. Price 1s.
21A. Fijian Plant Names, 1942. Price 3s. 6d., 4s. and 6s.
22. An introduction to the Mosquitoes of Fiji, 1943. Price 1s.
23. Insect Pests in Fiji, 1946. Price 1s.
Gardening Notes, Insect Pest Control and Plant Diseases, 1945. Price 1s.
24. The Botanical Gardens, Suva, 1948. Price 1s. 6d.

Applications should be made to the Librarian, Department of Agriculture, Suva, Fiji.

—EDITOR.

Agricultural Journal

VOL. 21 SEPTEMBER, 1950 NO. 3

CONTENTS

PAGE

EDITORIAL 61

STAFF NOTES 61

AGRICULTURE—

Notes on Rice Seed Bed Preparation 62

ENTOMOLOGY .. ..

Trichopoda Pennipes F. in Fiji and the British Solomon Islands *by B. A. O'Connor, B.Sc. Agric., B.A.* 63

ANIMAL HUSBANDRY—

Dairy Production in Fiji *By W. J. A. Payne, M.A. (Cantab), Dip. Agri. Sc. (Cantab), Ph.D. (Glasgow).* 72

EXTRACTS AND SHORTS—

The Peasant use of Fertilizers in Northern Rhodesia 80

Insecticidal Cement Paint 86

Prospects for Colonial Agriculture 88

Rice Varieties: A Correction 91

Local Bananas Blighted 92

ISSUED BY THE DEPARTMENT OF AGRICULTURE, FIJI.

Finest in their class

When you think of acquiring agricultural equipment to form a solid and reliable basis for a farming project, you naturally think of *Caterpillar products*—products which in the world of agriculture are supreme and bear a hall-mark in their name, as do a knife blade made in Sheffield and a ship built on the Clyde. These things are peerless in their particular spheres. You know that if you are fortunate enough to own or use one, you have the best that money can buy.

On the other hand if your agricultural requirements are of a smaller and more specialized nature, you still can do no better than consult *Suva Motors Limited,* the people who introduced and now deal in *Caterpillar* products in Fiji. They can for instance supply you with an *Allen Motor Scythe,* a light self-propelled and easily manoeuverable motor scythe designed for rapid, economical clearing of undergrowth and weeding of cultivated areas.

In fact for the best in everything—
Service, Attention and Equipment—go to:

SUVA MOTORS LTD

SUVA, FIJI

Agencies Include:

MORRIS CARS, TRUCKS, MARINE ENGINES. MICHELIN TYRES. CHRYSLER, DE SOTO, FARGO AND PLYMOUTH CARS AND TRUCKS. GARDNER DIESEL ENGINES. KELVINATOR REFRIGERATORS. ATHEY TRUSS WHEEL Co. UNITED STATES MOTORS CORPORATION. "GRANTEX" RICE MILLS. CHAPMAN MARINE ENGINES. EISEMANN MAGNETO CORPORATION. EXIDE BATTERIES. ALLEN SCYTHES. CATERPILLAR TRACTORS.

DEPARTMENT OF AGRICULTURE.

STAFF LIST (as at 30th September, 1950.)

ADMINISTRATIVE DIVISION—	
Director of Agriculture	C. HARVEY, C.B.E., B.Sc.(Agr.) A.I.C.T.A., M.L.C. (on leave).
	W. J. BLACKIE, M.Sc. F.R.I.C., F.N.Z.I.C. (Mem. Soc. Pub. Analysts) (Acting).
Deputy Director of Agriculture	W. J. BLACKIE, M.Sc., F.R.I.C., F.N.Z.I.C. (Mem. Soc. Pub. Analysts).
	B. E. V. PARHAM, O.B.E., M.A. (Hons.) (Acting)
Office Superintendent	J. S. RENNIE.
Grade II Clerk	Miss L. E. DUNCAN.
	R. T. CALDWELL.
	H. M. BENTLEY
Temporary Clerks	J. L. COLLINS.
	Mrs. M. C. DAVIDSON.
	Mrs. E. K. NARAYAN.
	Miss R. BENTLEY
VETERINARY AND FISHERIES DIVISION—	
Senior Veterinary Officer	A. F. S. OHMAN, M.V.Sc. (Melb.)
Veterinary Officers	K. J. GARNETT, B.V.Sc. (on leave).
	Vacant.
Senior Livestock Officer	T. P. GARDINER.
Livestock Officers	T. O. C. KERKHAM.
	R. S. VERA.
	F. L. CORBETT.
	Vacant.
Senior Meat and Dairy Inspector	C. H. KÖSTER.
Meat and Dairy Inspector	R. J. NESBITT.
RESEARCH AND LABORATORIES DIVISION—	
Senior Chemist, Government Analyst and Assayer	N. G. CASSIDY, M.Sc. (Q'ld.) A.R.A.C.T.
Entomologist	B. A. O'CONNOR, B.Sc. Agric., B.A.
Economic Botanist	*Vacant.*
Animal Husbandry Officer	W. J. A. PAYNE, M.A. (Cantab.), Dip. Agric. Sci. (Cantab.), Ph.D. (Glasgow).
Chemists	P. R. CHARLTON, B.Sc., A.N.Z.I.C.
	Vacant.
Laboratory Assistants	S. PILLAI.
	J. W. PARHAM. (on study leave).
Temporary Laboratory Assistants	Miss M. E. TURBET, B.Sc. (N.Z.)
FIELD AGRICULTURAL AND PRODUCE INSPECTION DIVISION—	
Senior Agricultural Officer	B. E. V. PARHAM, O.B.E., M.A. (Hons.).
	L. W. HARWOOD, H.D.A. (Acting).
Agricultural Officers	L. W. HARWOOD, H.D.A.
	R. R. MASON, B.Sc. (Agric. London), N.D.A. Dip. Agric. (Cantab.)
	N. LAMONT, M. Agric. Sc., (N.Z.)
	C. R. VASEY (Acting).
	A. D. MERCER, Dip. Agric. (Reading) (Acting)
	C. WHITEHEAD, Dip. Agric. (Q'ld.) (Acting)
	NIGEL COSTER, B. Agric. Sc. (N.Z.) (Temporary) (on study leave)
Registrar of Co-operative Societies	W. J. BLACKIE, M. Sc., F.R.I.C., F.N.Z.I.C. (Mem. Soc. Pub. Analysts)
Assistant Registrars	F. E. M. WARNER.
	RAVUAMA VUNIVALU, B.A. (N.Z.)
Chief Inspector of Co-operative Societies	RAVUAMA VUNIVALU, B.A. (N.Z.)
Weed Control Officer	A. D. MERCER, Dip. Agric. (Reading).
Marketing Officer	F. E. M. WARNER.
Farm Manager	W. GORDON.
Senior Agricultural Assistant	C. R. VASEY.
Soil Conservation Officer	C. WHITEHEAD, Dip. Agric. (Q'ld.).
Assistant Soil Conservation Officer	S. RAMJAN.
Agricultural Assistants	W. I. LAING, M. Agri. Sc., (N.Z.)
	S. BHARAT, Dip. Agri. (Allahabad).
	L. HARMAN.
	FILIMONE RAIQISO.
Produce Inspector	R. A. D. KABLE, M.B.E.
Librarian and Editor of Agricultural Journal	Mrs. M. C. DAVIDSON M.A., (N.Z.)

BURNS PHILP (SOUTH SEA) CO. LTD.

HEAD OFFICE: SUVA, FIJI

MERCHANTS, SHIPOWNERS, CUSTOMS & SHIPPING AGENTS

Branches :

FIJI: Suva, Lautoka, Ba, Levuka, Labasa, Sigatoka, Rotuma

TONGA : Nukualofa, Haapai, Vavau

SAMOA : Apia, Pago Pago

NORFOLK ISLAND and NIUE ISLAND

Agents For:

SHELL CO. (PACIFIC ISLANDS) LTD.
NEW ZEALAND SHIPPING CO. LTD.
SHAW SAVILL & ALBION CO. LTD.
PORT LINE LTD.
STANDARD MOTOR CARS
INTERNATIONAL TRUCKS
BERGERS PAINTS

"SHELL" PRODUCTS:—

"PENNANT" KEROSENE—Gives that much-desired brighter light.

"SHELLITE"—Your Petrol Lamp, Iron or Stove will be trouble-free if you use "SHELLITE."

"SUPER SHELLTOX"—This pleasant powerful insecticide sprays to kill all insects when used with a "Shelltox" Spray.

MOTOR SPIRIT—Use "SHELL" MOTOR SPIRIT for that extra mileage.

General Agents For:

QANTAS EMPIRE AIRWAYS LTD. and booking agents for member lines of THE INTERNATIONAL AIR TRANSPORT ASSOCIATION

Agents throughout the South Pacific for QUEENSLAND INSURANCE CO. LTD. transacting Fire, Marine, Hull, Motor Vehicle, Aircraft, Personal, Accident, Passengers' Baggage, Workmen's Compensation Insurance at lowest current rates

UNITED

ENGINEERS

PHONE 724

General, Marine, Steam, Petrol and Diesel Engineers
Blacksmiths and Oxy Welders

◆

Lawn mowers repaired and sharpened by special American Lawn mower sharpening machine.

OFFICE AND WORKSHOP : **BY-PASS RD., WALU BAY, SUVA**

EDITORIAL . . .

THE PLANT AND ANIMAL QUARANTINE CONFERENCE

An important step in international co-operation in the South Pacific area was taken early in April, 1951, when Suva became the venue for the Plant and Animal Quarantine Conference. Representatives of the six Governments participating in the South Pacific Commission met to discuss problems which, especially with the increase in air travel, are becoming daily more urgent and serious. Few places in our area are now so isolated as to be out of danger of undesirable importations in the form of weeds, pests, plant and animal diseases, and we realize that, quite apart from the well-known major examples, even seemingly innocent plants and insects, when moved from their natural habitat, may constitute a menace in their new surroundings.

The Conference has made suggestions regarding quarantine control of all aircraft, civil and military, including their proper insecticidal treatment, the establishment of adequate fumigation and incineration facilities at airports, and controlled plantings on or in the vicinity of airfields.

It has been recommended that there should be close co-operation with other Territories when framing or amending quarantine legislation so as to achieve greater uniformity in the measures adopted by the different Governments. To facilitate such co-operation, detailed lists have been drawn up showing the different plant and animal diseases against which each territorial administration should be on its guard. Examples of the pests and diseases discussed include some bugbears familiar to us, such as the rhinoceros beetle, and others much in the news elsewhere, such as swollen shoot of cocoa, leaf disease of rubber and rinderpest.

One of the most serious risks of importing undesirable weeds and insects lies in passing, without the strictest supervision, straw packing materials and fodder which may harbour pests and contain still viable weed seeds. For this reason the total exclusion from all Territories of rice straw and leaves and the rigid control of all other straw material has been recommended.

Close liaison is to be maintained between Territories, and in the event of any disease being identified for the first time in any one of them, all the others will immediately be informed.

As this branch of the many functions of the South Pacific Commission affects the well-being of a wider section of the islands populations than any other, it will be followed with great interest and the initial work done by the Conference should go far towards inspiring the general public with confidence in the aims and achievements of the Commission.

—M.C.D.

STAFF NOTES

Mr. W. J. Blackie, Acting Director of Agriculture, was appointed Registrar of Co-operative Societies (conjoint) with effect from 1st July, 1950.

Mr. A. D. Mercer, Weed Control Officer, was appointed to act as Agricultural Officer Southern with effect from 21st June, 1950.

The appointment of Mr. T. O. C. Kerkham, Livestock Officer, was confirmed with effect from 28th June, 1950.

Mr. H. M. Bentley, Grade II Clerk, assumed duty on the 1st September, 1950.

Mr. R. R. Mason, Agricultural Officer, was transferred from Lautoka to the Principal Agricultural Station, Koronivia, as Agronomist.

Mr. C. Whitehead, Soil Conservation Officer, was appointed to act as Agricultural Officer Western.

AGRICULTURE . . .

NOTES ON RICE SEED BED PREPARATION

By B. RAMNATH, FIELD ASSISTANT, P.A.S. KORONIVIA

During the 1948-49 season some 33,655 acres of land were cultivated for rice. If good quality seed had been used, and used carefully, 33,655 tins of padi would have been sufficient and this would have amounted to over 420 tons. Yet the majority of rice farmers have been using two, three or even more tins of seed for an acre of planted ground, so that some 840 or even 1,260 tons of seed padi have been used for sowing. Through not having used good quality seed and with not enough care bestowed on their seed-beds the rice farmers of Fiji have wasted perhaps over 800 tons of padi which after milling would yield at 2 lb. per day for 1,600 people for a whole year.

SEED SELECTION.

Padi seed should be collected by picking out the best and healthiest stalks from the previous years crop. By taking the greatest care each year to select only large heads, free from disease and from plants which had not fallen down, the crop will turn out better every year. The selected seed heads should be thoroughly dried and threshed by hand, not by bullocks as the seed is often injured by trampling.

PREPARATION AND SOWING OF SEED BED.

The seed-bed area should be a well chosen fertile piece of ground and should be well cultivated until the soil is soft and even. The seed may be soaked in water before sowing or sown dry when the weather is moist. It should be mixed evenly with the soil by raking and then covered with dry leaves to protect it from birds and from drying out. Eight days after sowing, the seed should be well up and the leaves should be removed. One 4 gallon tin of padi, which contains about 300,000 seeds, is sufficient for a plot 11 yards by 11 yards and this in turn should be enough to plant an acre. The plants should be ready for transplanting in 35 to 40 days. When clusters of plants are put out nine inches apart there are about 58,000 clusters to each acre, and if there are four plants to a cluster there would be 232,000 single plants per acre. This is less than the number of seeds in a tin, so that one tin of good seed if sown on a carefully prepared seed bed will yield enough plants for one acre.

CARE OF RICE AFTER PLANTING.

After planting, the rice should be well cared for in order that grass and weeds do not overgrow and choke it. Weed killing sprays such as " Weedone " will kill weeds such as " Jalkhumbi " (Water hyacinth), ' Loghaiya " (Yellow Willow herb), and " Laslashiya " (Tar weed), but will not kill grasses such as Muraina and Para which must be taken out by hand. One gallon of " Weedone " mixed with 80 gallons of water will spray 1 to 1½ acres and it should be remembered that it is not effective if applied in wet weather.

Sometimes padi fields are infested with " Gadihala " (Cutworm caterpillars) which may attack the crop at any time and frequently after the seed stalks appear. This insect will severely damage the padi if immediate action is not taken. To protect the crop the borders of the padi field should be kept clean and on the first signs of the pest the following bait should be spread. This comprises 25 lb of rice bran, 1 lb of Paris green, 1½ gallons of water, 4 pints of molasses and if desired the juice of six lemons. This bait if spread around the borders of the field will kill the caterpillars before they can get into the crop.

Farmers who are not sure how to use " Weedone " or the Paris green bait should contact the nearest office of the Department of Agriculture.

CONCLUSION.

Farmers should bear in mind that there are many people on these islands who need food. Rice is very important food and is in great demand. It would help a great deal to alleviate the position if farmers took care to prepare their seed-beds and land thoroughly and to plant and look after their crops wisely. So they would play their part in helping others and at the same time profit themselves.

It must always be remembered that to get good crops, good seed must be used.

ENTOMOLOGY . . .

TRICHOPODA PENNIPES F. IN FIJI AND THE BRITISH SOLOMON ISLANDS

BY B. A. O'CONNOR, B.Sc. AGRIC., B.A.

During December, 1949, a shipment of one hundred puparia of the *Tachinid* fly, *Trichopoda pennipes* F., a parasite of *Pentatomid* and *Coreid* bugs, was received from Florida. They had been forwarded by courtesy of Dr. F. J. Simmonds, of the Commonwealth Institute of Biological Control. The primary objective of the introduction was to attempt the establishment of the parasite in the British Solomon Islands, in the hope that it would bring about control of the *Coreid* bug *Amblypelta cocophaga* China, which causes disastrous premature nutfall in coconut palms. This bug has been controlled in some parts of the Solomon Islands by the ant *Oecophylla smaragdina subnitida* Emery, but in large areas, where the ant *Iridomyrmex myrmecodiæ* Emery is dominant, *Oecophylla* is apparently unable to become established, hence the need for another means of control. A secondary objective in importing *Trichopoda* was to establish it in Fiji, where it might help to control *Nezara viridula* Linn. and other phytophagous bugs. Actually *N. viridula* is rather well controlled in Fiji by the egg-parasite *Microphanurus basalis* Woll.

1. *Technique of breeding.*—T. *pennipes* is not easy to breed in large numbers, and an added difficulty in Fiji was the shortage of suitable hosts. In preliminary trials it was found that of the species of bugs commonly occurring here, *N. viridula* was the most suitable, as more puparia were produced from a given number of parasitised bugs than from a similar number of other species. Adult bugs only were used for breeding purposes, because the life-cycle of the parasite is lengthened in a nymphal host, and because it was desired to reduce overlapping of generations as much as possible. Also, a percentage of eggs laid on nymphs are lost, owing to occurrence of ecdysis before hatching of the egg has taken place.

The chief difficulties in breeding *T. pennipes* are associated with (*a*) mating and (*b*) oviposition. Notes on these are appended.

(*a*) *Mating.*—The method employed is as follows :—

As the flies emerge from the puparia, the males and females are separated, the males being placed in a large cage, 6′ x 6′ x 5′, made of white mosquito-netting, and suspended by cords at the four top corners inside the insectary. The cage may also be set up in the open, under a roof to keep out heavy rain, sticky bands being placed round the bases of the supporting poles to keep out ants (see Plate 1). Twigs of a plant with firm, glossy leaves, such as certain species of Ficus, are dipped in honey-water and suspended in the cage by wires, providing food for the flies. Sleeves in the bottom and one side of the cage provide access to the interior.

The female flies are left in small cages, 12″ x 12″ x 7″, with water and leaves dipped in honey water as food. These cages are collapsible, being constructed of five rectangular frames of galvanized fencing wire, which may be fitted together with spring-steel clips or tied together with twine or fine wire. Over the frame is fitted a cage made of white mosquito netting, the bottom three inches being made of doubled calico, through which is threaded a tape for drawing the cage tightly round the bottom of the frame. In one side is a sleeve 9″ in diameter. The base of the cage fits tightly into a shallow tray, with wooden sides and a masonite bottom. In the bottom of the tray are placed several thicknesses of blotting paper (see Plate 2). Cages with smooth surfaces, such as glass or celluloid, should not be used, as the flies cannot grip them properly, and damage and exhaust themselves by continual climbing and falling.

Plate 1 : Large cage for male Trichopoda set up in the open.

About two hours after the female flies emerge, when the distal end of the abdomen has become quite black, male flies which emerged on the previous day or earlier are introduced into the cage. Some mating usually occurs in the cage, and mating pairs may be lifted on one finger and placed in a separate cage. Most matings are obtained by placing a male and a female together in a small bottle, of internal diameter one inch, and height 1¼" (see Plate 3). The bottom and half the wall of the bottle are lined with filter-paper, to provide a foothold for the flies and it is closed with a cotton-wool stopper. When the flies mate, the bottle, with the stopper removed, is placed in an oviposition cage. One must be careful to see that copulation is actually taking place, as a male frequently remains mounted on a female for a considerable time without being able to mate. When all the day's females have been mated, as many as possible of the older females from oviposition cages are re-mated, and all the males are then returned to the large cage. (The wings of the males are frequently broken in the bottle, those of the females less often. However, their subsequent oviposition and mating seem to be unaffected).

This method works very well, and results in a very high proportion of matings. During a visit to the Solomon Islands, however, mating in bottles did not work as well as it had done in Fiji, though there were more matings in the cage. The reason for this is not known.

(*b*) *Oviposition.*—Our experience indicates that egg-laying occurs much more readily in a small cage than in a large one. Hence our routine has been to place five mated female flies in one of the small cages (12" x 12" x 7"), with 100 host bugs, food for the bugs consisting of beans strung on a wire across the top of the cage. In this way the flies lay much more readily than they do in large cages. They are fed on the

usual honey-water, and water is provided by sprinkling the cages, and on pads of cotton-wool. To avoid excessive super-parasitism, parasitised bugs are removed daily, and fresh bugs introduced. The females are re-mated every day, if possible, to reduce the number of unfertilized eggs.

Puparia.—Parasitised bugs are placed in large mosquito-netting cages of similar construction to the small one described earlier (see Plate 4), and are supplied with food. On the bottom of the cage is placed a layer of slightly moistened sand, about 1½" deep. As the time for pupation approaches, the sand is sieved daily, dead bugs being left on the sand, as mature parasite larvæ sometimes emerge after the death of the host. The puparia are placed between layers of cotton-wool in a 2-ounce tobacco tin, in the lid of which a number of large holes have been punched. The tins are stored in an airtight container, on the floor of which is a layer of damp sphagnum moss. The puparia are left in this saturated atmosphere until the time for emergence is near. Then they are placed in slightly moistened sand in the emergence cage.

This outline describes a technique which has worked very well, but could no doubt be improved upon. The use of honey-water causes a growth of black, unsightly fungus on the mosquito-netting, which could probably be avoided by treating new cages with a fungicide non-toxic to insects. As the flies cannot grip well on smooth surfaces, the mating bottle could perhaps be replaced advantageously by a small cylinder of mosquito-netting. The large cage could possibly be replaced by a smaller and less cumbersome one. Males which have been placed for an hour or two in a cage 2′ 6″ x 2′ x 2′, will frequently mate with females which later lay fertile eggs. Males have also been quite frequently mated on the day of their emergence with females which produced fertile eggs. However, older males usually

Plate 2 : Collapsible cages, used for oviposition.

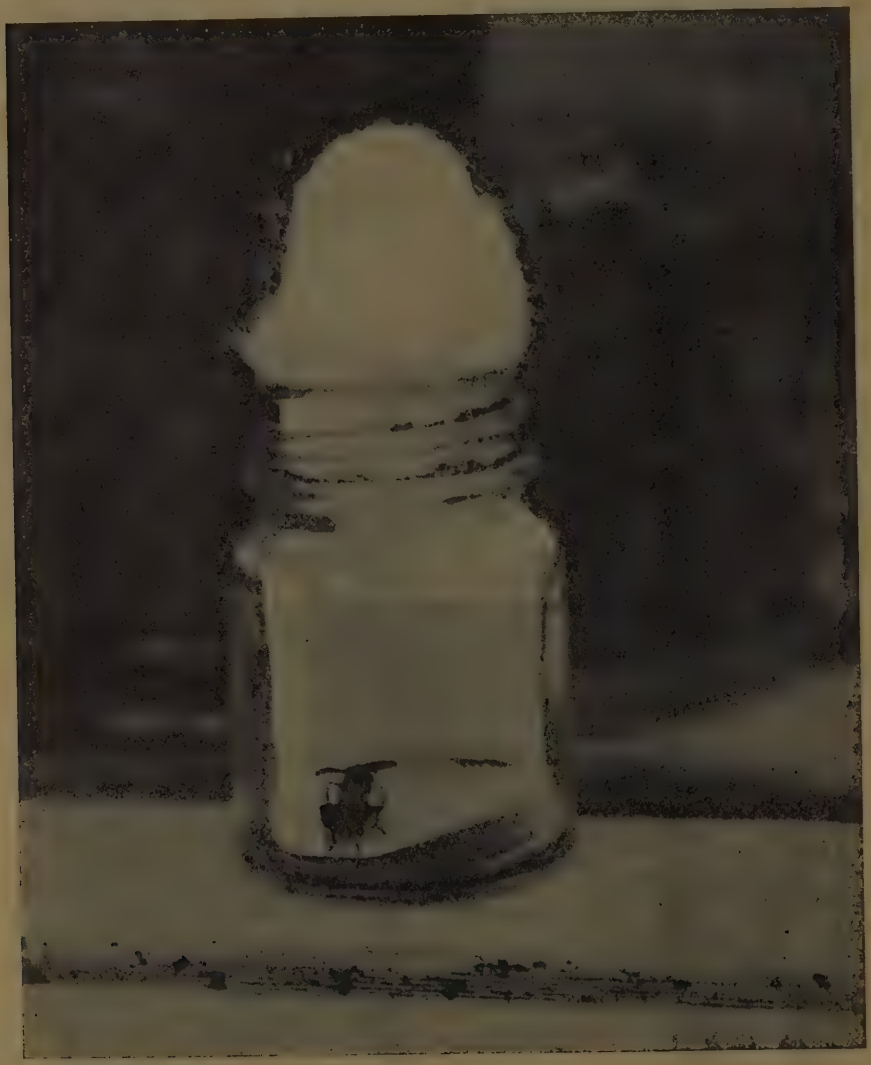


Plate 3 : Bottle used for mating.

mate more readily than new ones, and the males live longer in the large cage than in a smaller one. On a few occasions mating has occurred shortly after emergence in the small cages.

2. *Life-history and habits of T. pennipes in the insectary.*—During the warm season, when daily mean temperatures average about 80° F., emergence of the adults begins about 6.30 a.m., and most of the flies have

emerged before 10 a.m., though a few may appear as late as 1 p.m. During the cool season, with average mean temperatures of about 75° F., emergence normally occurs between 9 a.m. and midday. On a morning that is colder than usual, emergence begins at a later hour. The sexual ratio is 1 : 1.

Within an hour or two of emergence, the adults have hardened, and assumed their full coloration. Mating appears to occur most readily between females about one to six hours old and males one or more days old. Our practice has been not to mate the females until about two hours after emergence, when they are fully coloured, as some of those mated earlier failed to oviposit. Males will quite frequently mate within a few hours of emergence. They mate more readily with large females than with small ones. The costal area of the wing of the male is tan-coloured, while that of the female is black, like the remainder of the wing. The abdomen of the male is truncate, that of the female pointed, and often the distal end of the male abdomen is entirely red, while that of the female is black. During copulation, the flies remain still for several minutes, and can be handled without being disturbed.

Oviposition begins very soon after copulation, and continues until the death of the female. Most eggs are laid on the second, third and fourth days. The small cream-coloured or dark eggs are placed on the host almost instantaneously, and are held in position by an adhesive fluid. They may be laid on any portion of the host, and even on the cage in which the flies are confined. Oviposition is rather indiscriminate, as eggs have been laid on four species of bugs placed together in a cage, namely the *Pentatomids Nezara viridula* and *Tectocoris diophthalmus*, the *Coreid Leptoglossus australis* and the *Pyrrhocorid Dysdercus impinctiventris*, and many eggs may be laid on one host bug when numerous unparasitised individuals are available. As many as twenty eggs have been counted on one

Plate 4 : Large collapsible cage, used for feeding parasitised bugs.

Plate 5 : Front view of Insectary.

host individual. In the Solomon Islands, eggs were laid on the *Pentatomid Axiagastus campbelli* and the *Coreid Amblypelta cocophaga*, when these species were caged with the flies singly or together. Hence it seems that in nature *T. pennipes* may oviposit on numerous host species, some of which may not be suitable for its development. This is a factor which should definitely be borne in mind when introduction of the parasite to control a species of bug is contemplated.

A female fly can lay over 100 eggs. During one generation in the insectary, 80 females laid 6,400 eggs on 3,200 host bugs, an average of 80 eggs per female. In several cages which contained five or six females each, the average was over 100, so that it seems likely that some individual females may produce up to 150 eggs. The average longevity of the females was six or seven days, though they have been known to live as long as twelve days. Longevity of the males seems to be similar.

The larva, after hatching, ultimately finds its way to the abdominal cavity of the host, where it feeds with its anal end closed in a breathing funnel which is attached to a main tracheal trunk in the thorax. When fully-fed, the larva emerges through the anal opening of the host, or a nearby intersegmental membrane, and pupates in the soil. Emergence of the fully-fed larva from the host occurs shortly before or shortly after the death of the host. During the warm season in Fiji, with average daily mean temperatures of about 80° F., the time from oviposition to pupation of the majority of larvæ was 14 days, varying from 12 to 23 days, and from pupation to emergence of adults 12 days, varying from 11 to 13 days. Very rarely an adult emerged 9 or 10 days after pupation. When the period from oviposition to pupation was longer than normal, the resulting puparium was usually a very large one.

A limiting factor in the multiplication of *T. pennipes* is the comparatively small proportion of parasitised bugs which ultimately yield puparia. Using the method of breeding described earlier, only about 30 per cent to 50 per cent of parasitised bugs produce puparia, and of the puparia, normally only

a little over 80 per cent produce adult flies. As only one larva reaches maturity in each host, the yield of adults is about one from every three or four parasitised bugs.

3. *Liberation of T. pennipes in the British Solomon Islands.*—Early in May, 1950, some hundreds of puparia and several hundred parasitised bugs were taken by air to the British Solomon Islands. As the flies emerged, they were mated, and the mated females and some unmated males were liberated at Baunani Plantation, Malaita, in an area suffering from almost complete premature nutfall. Over a period of nine days, 205 mated females and 74 young males were released. Smaller liberations of mated and unmated females and some males were made on Guadalcanal, at Honiara and at Tenaru Plantation. In this vicinity, *Amblypelta cocophaga* has already been controlled by the ant *Oecophylla smaragdina subnitida*. During the time of the releases on Malaita, the weather was very favourable, and normally one expects cooler and drier weather during the period May to October than during the remainder of the year.

As *T. pennipes* appears to oviposit indiscriminately on many species of bugs, it is thought that most of its eggs will be laid on the species which is most numerous in the environment of the parasite. On coconut plantations in the Solomon Islands, by far the most numerous species occurring on the coconut palm is the *Pentatomid, Axiagastus campbelli*, which feeds, like *A. cocophaga*, on the young spadices. Hence it was thought to be important to know whether *T. pennipes* would breed on this species, which would probably receive most of the eggs of flies which frequented the spadices. The short time spent in the Solomons prevented large-scale trials, but it was found that the parasite can breed on *Axiagastus*. In cages, it laid its eggs on *A. campbelli* and *A. cocophaga* both singly and together. Regarding the effect of the parasite on *A.*

Plate 6 : Side view of Insectary.

Plate 7 : Interior view of Insectary.

cocophaga, it was thought that even if *T. pennipes* could not breed on this species, it might cause the death of parasitised individuals. However, the results of a single small trial were negative. Of 18 adult *A. cocophaga* on which eggs were laid, 11 were living fourteen days after oviposition. When these were dissected, no parasite larvæ were found, and no puparia were produced from the dead bugs. Hence the prospects of successful control seem rather doubtful. However, it is hoped to carry out more extensive trials on a later visit to the Solomon Islands.

The Insectary.—As a matter of interest, some photographs of the insectary which has proved useful for breeding *T. pennipes* and other insects have been included, and some notes on its construction are appended.

In designing the building, the main requirements were that it should have plenty of light, so that plants would grow well in it, and that it should be proof against ants and rats. Good lighting was ensured by using a reinforced glass roof, and walls of gauze set in plastic, the latter admitting plenty of light, but not concentrating the heat. Plastic sheets would no doubt have been preferable to reinforced glass for the roof, but were too costly. The walls are ten feet high, and at the level of the top of the walls there is a white calico ceiling, suspended by brass rings from wires running along the sides of the building, and supported in the middle by wires which run from end to end of the insectary. This ceiling mitigates the heat from the glass roof, and on dull days may be slid back on the wire rings to admit more light. Most of the walls consist of hinged portions which may be opened and secured at right angles to the wall by hooks, so that free circulation of air is obtained.

The floor is of concrete, extending outside the walls, and a small trench in the outer portion surrounds the building, and is kept full of water, to which insecticide may be added if necessary, thus preventing the ingress of ants. Rats are excluded by lining the inner surface of the four walls with half-inch galvanized wire netting. Netting is

also placed over the exit of a drain pipe, which is situated in one corner of the building under the sink. The floor is sloped very slightly towards this corner, so that when the floor is washed the water will flow in that direction. A bench runs round the walls, and a table twelve feet by four feet stands in the middle. The dimensions of the insectary are twenty-four feet by fifteen feet.

This building has proved very suitable for breeding insects on growing plants. The temperature on the hottest days, with all the windows open, has not exceeded 95° F., a few degrees above the outside shade temperature. It is thought that this type of structure is very suitable for tropical island climates, especially in localities like the south-eastern corner of Viti Levu, where many very dull days are experienced.

MOTOR MOWERS

BY

RANSOMES

14″ and 18″ Minor 2-stroke

A highly efficient low priced machine for small lawns

16″ 4-stroke

These models, suitable for medium sized lawns and tennis courts, have that smoothness and silence of operation which a precision build 4-stroke engine gives

18″ Gazelle 2-stroke

A dual purpose mower which deals with rough grass most efficiently and will also leave a lawn with a very fine finish

Full details available at

MORRIS, HEDSTROM, LIMITED

The Store for Service and Economy

AGENTS FOR RANSOMES, SIMMS AND JEFFRIES

ANIMAL HUSBANDRY . . .

DAIRY PRODUCTION IN FIJI

1. A SHORT REVIEW OF THE PROBLEM OF ACCLIMATIZATION OF DAIRY CATTLE TO THE LOCAL ENVIRONMENT

BY W. J. A. PAYNE, M.A. (CANTAB.), DIP. AGRIC. SC. (CANTAB.), PH.D., (GLASGOW).

INTRODUCTION

There were no indigenous cattle in the South Pacific before the discovery of the island by Europeans. Strains of both European and Indian stock are now to be found in the islands, European breeds having been introduced first. In relation to long term needs, the stock population in the islands is low, and relatively large importations will have to be made for a long time to come. In the past this importation has been on a 'hit or miss' principle with varied and not very satisfactory results.

It is in the interest of dairy farmers in the islands to concern themselves more intimately with the problem of acclimatization of dairy stock. One purpose of this series of articles is to interest island dairy farmers in the type of stock that might give the highest production under local climatic conditions.

THE LOCAL CLIMATE.

The two major islands of the group have a varied climate. Both islands are fairly large and hilly and have at least two distinct climatic zones. A wet tropical rain-forest area on the windward side and a dry open savannah area on the leeward side. In both islands there is an intermediate climatic zone possessing some of the climatic features of both the wet and the dry zones but smaller than either in total area. Table 1 and 2 and Figure 1 give details of the mean temperatures and rainfall at stations in the wet, dry, and intermediate zones on the island of Viti Levu.

TABLE 1.

MEAN MONTHLY MAXIMUM AND MINIMUM TEMPERATURES (°F) AT THREE STATIONS IN THE THREE MAIN CLIMATIC ZONES OF VITI LEVU.

Month.	Suva[1] Wet Zone.		Sigatoka (A.S.S.)[2] Intermediate Zone.		Lautoka (C.S.R.)[3] Dry Zone.	
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.
January	86.0	74.2	87.7	70.0	88.0	73.2
February	86.5	74.6	88.0	71.0	88.9	74.0
March	86.1	74.3	88.3	70.6	88.1	73.3
April	84.3	73.1	85.7	69.4	87.2	72.4
May	81.8	71.4	82.9	66.2	85.3	70.3
June	80.2	69.4	80.9	63.2	84.1	67.5
July	79.0	68.1	80.4	62.2	83.4	66.6
August	79.0	68.3	81.2	64.0	84.0	67.1
September	80.0	68.9	82.2	64.4	84.1	68.0
October	81.5	70.4	83.8	65.5	85.8	70.0
November	82.9	71.7	85.4	66.4	87.0	71.2
December	84.8	73.2	86.5	69.1	87.5	72.0
Mean.	82.7	71.5	84.5	66.9	86.1	70.5

(1) Suva 1886-1940.
(2) Sigatoka 1938-1945.
(3) Lautoka 1930-1941.

TABLE 2.

MEAN MONTHLY RAINFALL (IN) AT THREE STATIONS IN THE THREE MAIN CLIMATIC ZONES OF VITI LEVU.

	Suva[1] Wet Zone.	Sigatoka[2] Intermediate Zone.	Lautoka C.S.R.[3] Dry Zone.
January ...	11.77	9.43	9.14
February .	11.0	9.15	11.99
March ...	14.90	10.53	12.20
April ...	12.32	7.41	6.19
May ...	10.73	5.02	4.47
June ...	6.27	2.74	2.22
July ...	5.44	3.02	1.92
August ...	8.04	3.15	3.04
September.	7.78	3.42	2.55
October ...	9.07	4.05	3.39
November.	10.25	4.51	4.15
December .	12.80	7.22	7.80
Total ...	120.46	69.65	69.06

(1) Suva 1884-1940: 1885 incomplete.
(2) Sigatoka 1927-1945.
(3) Lautoka C.S.R. 1901-1945.

It will be seen that the temperatures are not extreme in any zone and that there is a fair diurnal variation. There is a wide variation in rainfall in the three zones. All zones have a marked seasonal variation and the rainfall is very low in the ' dry ' zone in the winter months, and very high in the ' wet ' zone in the summer-time. It will readily be seen that the most suitable climate for arable or mixed husbandry is in the intermediate zone where temperatures are always lower and the dry season is not so severe as in the dry zone, and the wet season not so wet as in the wet or the dry zone.

This climate affects dairy animals in two ways. They are directly affected by temperature, humidity, rainfall, atmospheric pressure, and radiation, and indirectly by the effect of these climatic factors on their food supply and on the parasites and diseases to which they are subject. This article will only consider the direct effects of the local climate. Their food supplies and nutrition will be considered in another article. Fortunately the islands are comparatively free from acute animal disease. The major direct climatic effect is that of air temperature and this will be considered in some detail.

THE HEAT-REGULATING MECHANISM IN DAIRY ANIMALS.

Warm blooded animals such as dairy cows can only tolerate relatively small variations in body temperature. Their bodies are tuned to maintain an approximate balance between heat production within the body and heat loss from the body. As they move about, grazing or cudding, heat is produced, and as the external temperature rises the problem of heat disposal becomes more complex. The cow like other mammals has a central heat regulating mechanism that acts something like a thermostat and is situated in the hypothalamus. It regulates heat loss through a number of complex nervous mechanisms.

The cow's body loses most of its heat from two surfaces, the skin, and the epithelium of the respiratory system, by (*a*) radiation, conduction and convection, and (*b*) vaporization of water. Heat is also lost by the excretion of fæces and urine, but these losses are negligible.

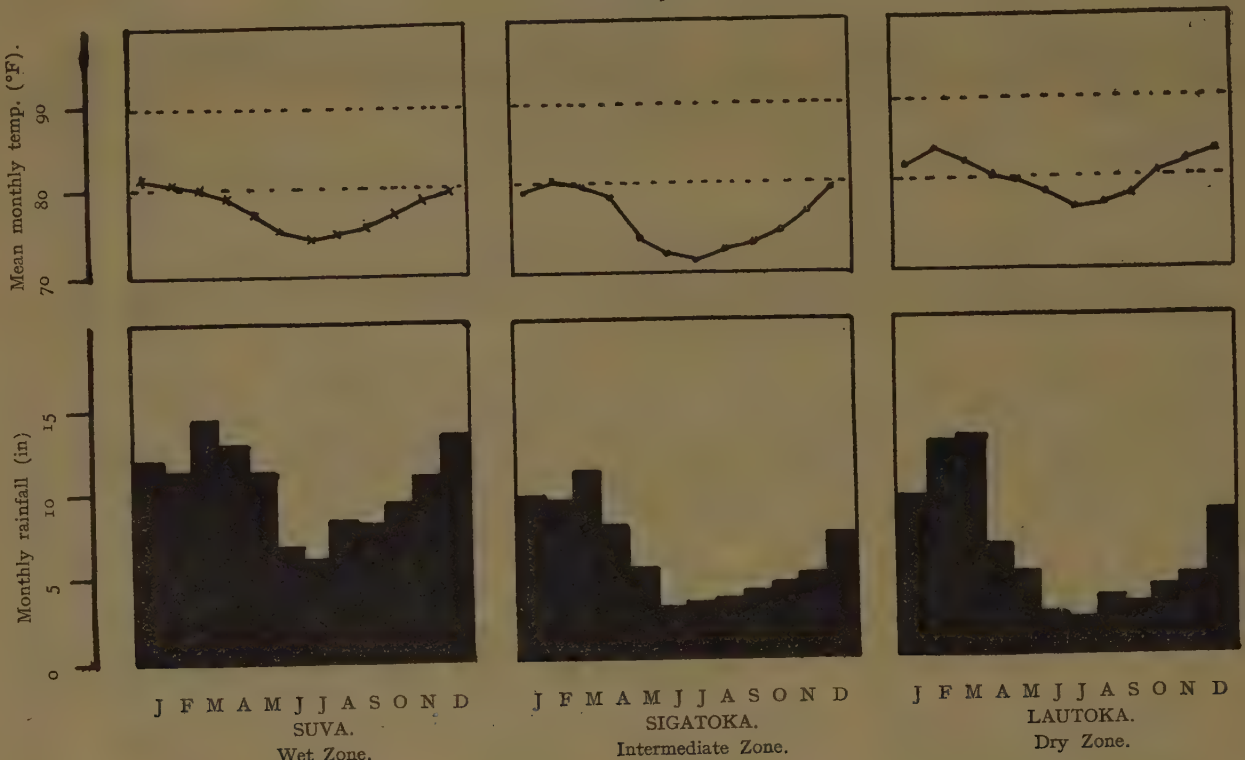
In a temperate climate 75 per cent of the excess body heat is lost by radiation, conduction, or convection, radiation being the most important, (Du Bois, 1937). These losses are affected by the flow of blood to the skin capillary network, the degree of dilation of the skin capillaries, the dilution of the blood, the thickness of the skin, the type and density of hair, the body surface area, and the external temperature.

Heat produced inside the body is carried to the surface by the blood, dilution of the blood increases heat loss as water has a high heat capacity. Vasodilation in the skin also increases heat loss as a greater volume of blood is carried more quickly to the surface. The degree of erection of the body hair and the density of hair follicles per square centimeter of skin surface affect heat loss, as a dense mat of hair will trap a layer of still air around the body surface and so help to conserve heat. Thickness of the skin affects the passage of heat from the capillary network to the outer surface area from which radiation can take place.

The other major factor in a temperate climate is loss due to vaporization of water at the body surface. The vaporization of

FIGURE 1

Mean monthly temperatures and monthly rainfall at stations in three climatic zones in Fiji.



1 gm. of water allows the body to lose 0.58 calories of heat. Loss by this method is under the control of the sweat nervous mechanism but the rate of loss depends on many factors such as the number of sweat glands per square centimetre of skin, the total surface area, the external temperature, the external humidity, and the rate of air-flow over the surface at which vaporization takes place.

As the external temperature rises loss of heat by radiation, conduction or convection becomes less important, and loss by vaporization of water more important until at the stage when the external temperature is identical with the body temperature there is no loss by radiation, etc., and if the external temperature rises above this the animal may even gain heat instead of losing it.

DESIRABLE CHARACTERISTICS FOR DAIRY CATTLE IN FIJI.

Thus under the tropical conditions existing in these islands animals with well developed sweat glands, sparse coarse hair, and a large body surface in relation to volume will be best able to cope with the high external temperatures, often associated in the wet season with a high humidity.

It follows that a desirable type of dairy animal for use in Fiji must combine, high yields of milk and butter fat with heat tolerance, or ability to lose surplus heat. There are also several other attributes that are necessary, such as a pigmented skin to prevent sunburn .

HEAT TOLERANCE.

It is unfortunate that in the past selection for high milk and butterfat yield has been restricted almost entirely to the European breeds. Thus the progressive milk producer in a tropical country wishing to raise the inherent productive ability of his herd as quickly as possible looks in the first place to the European breeds not realizing that it is essential that the tropical dairy cow should possess other attributes, such as heat tolerance.

There is now a considerable volume of evidence that cattle of the Zebu type (Bos indicus) withstand tropical conditions better than cattle of the European type (Bos taurus). French (1941) has suggested that the inability of some European cattle to thrive when introduced into tropical countries may be connected with their failure to properly regulate body temperature. Kendall (1948) states that high grade Friesian stock do not thrive in Tanganyika and has shown that in high atmospheric temperatures the rectal temperature of a native Zebu type, the East African Boran, does not rise as high as that of the high-grade Friesians. Rhoad (1938) working under sub-tropical conditions in Louisiana demonstrated that during the course of a summer day the body temperature and respiration rate of all cattle rose and fell but that the rise was highest in European stock (Aberdeen Angus) and lowest in Zebu stock with the cross-breeds exhibiting intermediate values. He has since devised a simple field test for measuring the heat tolerance of animals (Rhoad, 1944) and has shown quite definitely that Zebu type stock have the highest coefficient of heat tolerance (Table 3).

TABLE 3.

SCALE OF HEAT TOLERANCE FOR CATTLE AS DETERMINED BY THE IBERIA HEAT TOLERANCE TEST AT JEANERETTE, LOUISIANA, IN 1944 (AFTER RHOAD, 1944).

Breeding.	Sex.	Numbers. Animals.	Numbers. Tests.	Coefficient of heat tolerance.*
Zebu	F	7	18	89
½ Zebu: ½ Angus	F	19	67	84
⅜ Zebu: ⅝ Angus	F	8	21	84
Santa Gertrudis .	F	7	21	82
½ Africander: ½ Angus	F	22	64	80
Jersey	F	34	34	79
¼ Zebu: ¾ Angus	F	54	165	77
Grade Hereford	M	12	12	73
½ Africander: ½ Angus ...		4	9	72
Angus	F	31	69	59

* Coefficient of 100 would be perfect efficiency in maintaining body temperature at 101.0° F.

It is of some interest to note from Table 3 that within European breeds the Jersey has a relatively high coefficient of heat tolerance,

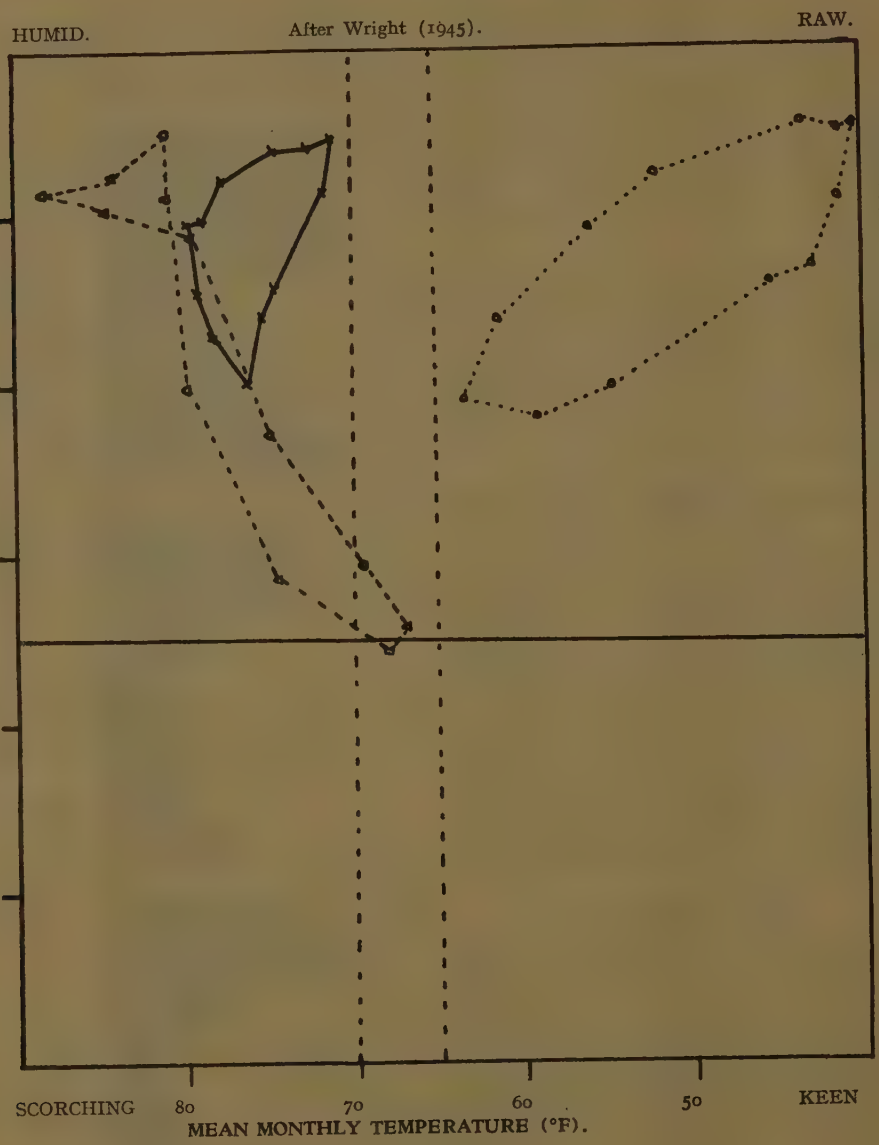


FIGURE 2

Climatographs for London (typical of the natural environment of some European breeds, Karachi (typical of the natural environment of some Indian breeds) and Sigatoka, Fiji.

and the superiority of the Jersey over the Holstein-Friesian has also been noted by Freeborn, Regan and Berry (1934) who found that Jerseys were more heat tolerant at temperatures of 75°, 80°, and 85° F. Seath and Miller (1947) have also shown that the Jersey is more heat tolerant than the Holstein-Friesian. Body temperatures increased more rapidly in Holstein-Friesian than in Jerseys as a result of increases in the external temperature, and Holstein-Friesians frequent shady spots more often than Jerseys when they are grazing under the same conditions. Phillips (1948) also quotes evidence from Greece that the Brown Swiss breed has a relatively high heat tolerance. He suggests that the heat tolerance of this breed should be further investigated.

The reasons for the superior heat tolerance of certain breeds of cattle are not well understood and it is probable that several factors are involved.

Kelley (1932) has suggested that it would appear that by Miocene times the Bos family that was concentrated in South East Asia differentiated into two types the Aurock, that became the progenitor of Bos taurus, and spread over Central and Northern Europe and the Zebu or Bos indicus that spread over Southern Asia and into Africa.

The Zebu is typically short-haired, has a pigmented skin, long horns, and a large area of skin in relation to body volume, and has evolved over a long period in tropical or sub-tropical areas and is more likely to be acclimatized to tropical conditions than European cattle. The occurrence of more functioning sweat glands per unit of body surface would certainly improve the ability of the animal to dispose of excess body heat at high atmospheric temperatures. Yamane and Ono (1936) examined the skins of Sind-Zebu, Kankrej-Zebu, Formosan, and Friesian cattle and they showed that the sebaceous and sweat glands are large and numerous in the Zebu, while they are small and few in the Friesian. They state that the skin structure of the Friesian is very unfavourable to acclimatization to tropical temperatures. Kelley (1932) also examined the skins of a few crossbred Zebu and one pure Friesian animal, and found that in a microscopic field of 0.8 sq. mm. of skin there were averages of 9.33 and 5.25 sweat glands respectively in the half-bred and quarter bred Zebu while in the same area of the Friesian skin the sweat glands were few in number and very difficult to find.

A greater skin area in relation to body size would also be expected to increase heat tolerance as there would be a greater surface for radiation and more sweat glands per unit of body volume. Kelley (1932) also states that in experiments conducted by the United States Bureau of Animal Industry the cross-Zebu hides showed a larger surface in eight out of nine comparisons with Hereford or Shorthorn hides.

The colour of the coat may also be a factor as animals with light coloured hair reflect more light. Rhoad (1940) and Bonsma (1943) have made observations on this and have shown that animals with light coloured coats, such as most Zebu stock or the Jersey possess, reflect the most sunlight. The thickness of the coat and the rate of growth of the hair are probably also factors that should be considered. Riemerschmid and Elder (1945) determined the ' mean effective absorptivity ' of cattle coats of different colours and found that it was least in a white Zebu and highest in a black Aberdeen Angus. French (1946) observed that pure-bred Zebu cattle had a slower rate of hair growth than cross-bred Zebu-Friesian and Zebu-Ayrshire cattle, and he also noted a tendency for animals with woolly coats to have a faster rate of hair growth.

Thus it would apear that since Miocene times cattle of the Zebu type have been living in the tropics and sub-tropics and that they have developed a series of mechanisms that have not yet been fully investigated and that enable them to thrive in the high atmospheric temperatures found in these regions. European cattle do not possess these mechanisms to the same degree, but there are wide differences between the European breeds, and that from the investigations that have been quoted the Jersey would appear to be more heat tolerant than other breeds.

THE ACCLIMATIZATION OF EUROPEAN BREEDS OF CATTLE.

The major importations into Fiji have been from European stock but there has been no standard by which to measure how well these imported animals have done, in their new environment. In future information should be available from the two government stations as stock have recently been imported from Australia.

Wright (1945) in a report on milk production in Ceylon states that European breeds of cattle will only thrive where the mean annual temperature falls below 65-70° F, although he admits that individual breeds and individual animals within the breed vary in their heat tolerance. It will be seen from Figure 1 that in all zones in Viti Levu, the largest island in the Fiji Group, the mean monthly temperature is always above that which is considered the maximum for European cattle by Wright.

What are the physiological effects of keeping European stock under these conditions ? Wright states that the combined effect of seasonal variations in the mean temperature and humidity can be depicted by a ' climatograph ' in which the mean levels of temperature and relative humidity are plotted for each month, in order, and the resulting points joined to form a composite figure (Figure 2). He has shown by means of climatographs of this type that dwarfing of cattle occurs in hot humid climates, as climatographs for five areas where dwarf breeds are found all fall in the same area of the graph. A climatograph for Sigatoka also occurs in the hot humid section of the graph (Figure 2). Thus dwarfing may be expected. Unfortunately there are no comprehensive records in the islands but personal observation of pure-bred or almost pure-bred European herds would suggest that there has been considerable diminution in size. There are now some records of calf birth-weights from the Sigatoka Friesian herd (Payne, 1949). The average calf weighs 69.5 pounds compared with 89 pounds in Friesian herds in America (Eckles, 1949). It is impossible to say at this stage of the investigations whether the low birth-weights are due to a low plane of nutrition or to the high temperature or to both factors or to other cases.

Although there does appear to be some ' dwarfing ' the production of some European type dairy animals in the islands is not low. In 1949 four out of seventeen unselected grade Friesians at Sigatoka produced more than 700 gallons in a lactation (Payne, 1950). Turbet (1949) states that dairy farmers in the islands prefer European to Zebu type cattle as they are more profitable. However the Zebu type cattle in Viti Levu are almost all descendants of importations of Nellore (not a milk type of Zebu) and this may explain the preference. Wright himself has suggested that breeds and individuals within breeds vary in their tolerance to tropical conditions. It could be that natural selection has already started on a small scale and that when European type cattle are brought into a tropical environment into which only a few may be able to fit themselves, selection is speeded up through the action of the dairy farmer who culls out rapidly those animals unfit for the local environment. Seath (1947) investigated the heritability of heat tolerance as indicated by variations in body temperature and respiration rate in Jerseys and Holstein and his work suggested that the estimate of heritability of body temperature (15-30 per cent) was of the same order as that of production records. Gaalaas (1947) studying records in a Jersey herd found differences in different age groups but did not repeat Seath's findings. Despite the differences between these reports it would be reasonable to assume that the factors concerned with heat tolerance are inherited and that some or all of them occur occasionally in individuals amongst the European breeds.

The possibility that some European type stock in the islands have been unconsciously selected for heat tolerance and for fitness for the local environment should not be ruled out. At Sigatoka the heat tolerance coefficient of cows in the grade Friesian herd varied from 73 to 85 in the summer months 1949-50 (Payne, 1950). The average heat tolerance of the four animals, mentioned above as producing more than 700 gallons

per lactation in 1949, was equivalent to the average for Santa Gertrudis cattle (a beef breed derived from crossing European and Zebu types of cattle). Thus it would appear that it should be possible to consciously select European type dairy animals for heat tolerance and adaptibility to the local environment. The possibility of this and the work in progress at Sigatoka will be further discussed in a future article.

SUMMARY.

1. Some details of the local climate are given. These show that the monthly mean temperatures are above the level (65-70° F) generally considered suitable for the proper growth and production of European type dairy stock.

2. The heat regulating mechanism of dairy animals is discussed, and a brief review is given of the available information on heat tolerance.

3. What information is available suggests that there is a ' dwarfing ' of European type dairy animals in the islands, although the production of individual animals can be fairly high.

4. The thesis that it might be possible to breed European type dairy cattle suitable for the local environment is briefly discussed.

REFERENCES.

Bonsma, J. C. (1943).—Farm. S. Africa, 18, 101.

Du Bois, E. F. (1947).—*The Mechanism of Heat Loss and Temperature Regulation.* Stanford Univ.

Eckles, C. H. (1939).—*Dairy Cattle and Milk Production.* 3rd Ed., New York.

Freeborn, S. B., Regan, W. M., and Berry L. J. (1934) J. Eco. Ento., 27, 382.

French, M. H. (1941).—E. African Agric. J., 6, 189.

French, M. H. (1946).—E. African Agric. J., 11, 181.

Gaalaas, R. F. (1947.—J. Dairy Sci., 30, 79.

Kelley, R. B. (1932).—C.S.I.R. Pamphlet No. 27, 11 and 37.

Kendall, S. B. (1948).—Vet. J., 104, 112.

Payne, W. J. A. (1950).—Dep. Agric. Fiji. Ann. Rep. (In the press).

Payne, W. J. A. (1950).—Unpublished data.

Phillips, R. W. (1948).—*Breeding Livestock Adapted to Unfavourable Environments* F.A.O. Agric. Studies No. 1, Washington.

Rhoad, A. O., (1940).—Emp. J. Exp. Agric., 8, 190.

Rhoad, A. O. (1948).—Amer. Soc. Anim. Prod. Proc., 284.

Rhoad, A. O. (1944).—Trop. Agric., 21, 162.

Riemerschmid, G. and Elder, J. S. (1945).—Onderstepoort J. Vet. Sci. and Anim. Hus., 20, 223.

Seath, D. M., and Miller, G. D. (1947) J. Anim. Sci., 6, 24.

Seath, D. M. (1947) J. Dairy Sci., 30, 137

Turbet, C. R. (1949) Agric. J. Fiji, 20, 70.

Wright, N. C. (1945).—*Report on the Development of Cattle Breeding and Milk Production in Ceylon.* British Colonial Office, Eastern No. 179.

Yamane, J., and Ono, Y. (1936.—Memoirs Fac. Sci. and Agric. Taihoku Uni., 19, 87.

THE

FORDSON MAJOR

TRACTOR

Equipped to put Power in your land with new, more advanced models. The " Major ", latest post-war Fordson, has a wealth of improvements. Modern farmers everywhere acclaim its ample power, enduring strength, extreme ease of handling and constant economy

Full details available at—

MORRIS, HEDSTROM, LIMITED

THE PEASANT USE OF FERTILIZERS IN NORTHERN RHODESIA

In asking for a share in the limited world supplies of fertilizers we in Northern Nigeria are uneasily conscious that our claims may secure earlier recognition than those of territories whose needs are perhaps more acute. We are in the first place fortunate that our main agricultural export crop, groundnuts, has a well-assured market, and that it has been recognized, however belatedly, that unless we are to jeopardize the land reserves needed for a rapidly expanding population, an annual export of 300,000 tons of shelled nuts, containing 3,000 tons of phosphoric anhydride, cannot be maintained without the return to the land of an equivalent amount of phosphatic fertilizer (17,000 tons of single superphosphate). We are doubly fortunate in being able to show that, thanks in part to a good system of rail and road transport and in part to a ready response by Northern soils to very small applications of one of the cheapest phosphatic manures, the use of single superphosphate by the peasant farmer would, over the area readily accessible by motor transport, prove highly economic, both for staple foodstuffs and for export crops.

When fertilizer trials were interrupted by the last war it had already been established that the response of the soils of Kano and Kateina Provinces to superphosphate was of the same order as that shown by the soils of Zaria Province, where applications of 50 lb. superphosphate per acre had been found to give increases in yield equal to those obtained by the use of 1 ton of pen manure containing an equal amount of phosphoric acid(1). It had also been shown at Kano that on the light sands of the main groundnut area a significant residual effect could be detected in the fourth year following treatment with superphosphate(2). From the data then available it was possible to predict with some certainty to the Oilseeds Commission of 1946 that on average soils, with a yield of 800 lb. or less of groundnut kernels per acre, an application of 50 lb. superphosphate per acre would produce an added yield of 200 lb. kernels. At present prices superphosphate powder (18.5 per cent) can be landed in Kano at £20 per ton. This happens to be the current price for groundnuts. The farmer may therefore expect a fourfold return on his expenditure on fertilizers.

A further increase in the farmer's margin of profit was promised ; first by the use of the more concentrated phosphatic fertilizers which would bear a lower transport charge per unit of phosphoric acid, secondly by the adoption of placement technique to ensure full benefit from the use of small applications. Since the resumption of fertilizer work in 1947 a number of experiments have been made with various types of phosphatic manure to find a method of placement which the peasant farmer is likely to adopt.

FERTILIZER POWDERS.

Considerable danger attends the use of neat fertilizer powders in unskilled hands, particularly with groundnuts, which are sensitive to contact even with the less soluble fertilizers. It was thought, however, that if a safe fertilizer/soil ratio could be prescribed the farmer could be persuaded to mix one measure of fertilizer with a given number of measures of soil and apply the mixture to the planting holes by means of a standard ladle.

This method may still have practical application in the case of sorghum, with which super/soil ratios of 1/16 and 1/25 were found safe with applications of 50 lb. and 200 lb. superphosphate per acre respectively. It seemed unlikely to be of value in the case of groundnuts on account of the large volume of mixture which the farmer would need to carry. A 1/30 super/soil mixture caused set-back at 50 lb., and a 1/55 mixture depressed early growth at 200 lb. superphosphate per acre. For the more soluble fertilizers a much wider ratio is required : sulphate of ammonia retarded early growth when applied at the rate of 25 lb. per acre in a 1/400 mixture.

Powder/soil mixtures have, therefore, not been given extended trial. The results of a series of field experiments made in Zaria, Kano, Katsina and Bauchi Provinces in 1947 are of interest since at Kano, where the stand-dosage of superphosphate (1.2 to 4.8 gm.) was mixed with a 4" cash-bowl of soil (about 250 gm.) and applied to the planting-holes of groundnuts a significant increase due to 50 lb. superphosphate was for the first time recorded on land with a non-manured yield of over 1,000 lb. kernels per acre. [No manure = 1,216 lb.: 50 lb. super = 1,431 lb.: 100 lb. super = 1,501 lb.: 200 lb. super = 1,386 lb. Sig. Diff. 1 % = 197.]

A parallel Kano experiment with sorghum in which the stand-dosages of superphosphate (2.4 to 9.6 gm.) were similarly diluted with 250 gm. of soil is quoted on account of the notable residual effect shown by groundnuts in the two following years. In this trial the super/soil mixture was applied in two ways :—

(*c*) placed in the planting-hole immediately before planting.

(*s*) spread in a thin line along the midpoint of the ridge prior to planting.

TABLE I.

Treatment.	Manured 1947. Sorghum. grain (lb. acre).		Residual 1948. Groundnuts. Kernels (lb. acre).		Residual 1949.	
No manure	746	Diff.	834	Diff.	492	Diff.
Super 50 lb. (s)	899	+ 153	1,068	+ 234	610	+ 118
,, 50 lb. (c)	1,117	+ 371	1,227	+ 393	680	+ 188
,, 100 lb. (s)	1,098	+ 352	1,200	+ 386	665	+ 173
,, 100 lb. (c)	1,123	+ 377	1,062	+ 228	641	+ 149
,, 200 lb. (s)	1,137	+ 391	1,275	+ 441	642	+ 150
,, 200 lb. (c)	1,141	+ 395	1,195	+ 361	610	+ 118
Sig. Diff. 1%		306		138		117
5%		227		102		87

PELLETED FERTILIZERS.

The Groundnut Mission (1947) visited Nigeria shortly after the above experiments had begun. They were fervent advocates of placement technique and encouraged us to make up the stand-dosages of various types of fertilizer into pills which could be placed with the seed. They promised help in obtaining pills for large-scale trials should the method promise success.

Preliminary trials in 1947 with spherical pills made locally from superphosphate, triple super and monammonium phosphate showed that they could be safely placed by only slight modification of local methods of planting. Field-tests of commercially made pellets (aspirin-type) were then made with groundnuts in 1948, when 63 farmers gave a first trial to pellets of triple super and single superphosphate containing binding material. In the present year commercial and local types of pellet have been used in experiments with groundnuts, sorghum and cotton. At each of nine centres superphosphate pellets have been issued to permit 44 farmers to carry out trials with both sorghum and groundnuts. It was intended that with both crops comparative tests of locally made low-pressure tablets and imported high-pressure pellets should be made. The late arrival of the pellets has at many centres limited their use to groundnuts only.

Details of these experiments will be presented elsewhere. The main conclusions likely to influence peasant acceptance of fertilizers are given below.

TYPE OF FERTILIZER.

Trials have been made with bone phosphate, single super, triple super monammonium phosphate and triple super-ammonium sulphate. The outstanding result with groundnuts has been the superiority of single superphosphate over the other manures. It has produced plants with conspicuously greener and more abundant

foliage and with a significantly higher kernel yield. The following experiment, made at Samaru (Zaria) in 1948 with high-pressure pellets giving 11 lb. P2 05 (60 lb. single super) per acre at a spacing of 9″ x 3′ is typical of many others.

TABLE II.

Treatment.	Kernels (lb. acre).	Diff.	Dry haulms (lb. acre).	Diff.
No Manure	1,200		1,216	
Bone phosphate	1,342	+ 142	1,253	+ 37
Triple super	1,448	+ 248	1,273	+ 57
Amm. phosphate	1,467	+ 267	1,246	+ 30
Single super	1,571	+ 371	1,681	+ 455
Sig Diff. 1%		149		231
5%		113		173

[Yields from manured plots are means for two methods of placement ; hence the difference in kernel yield between single super and ammonium phosphate (+ 104 lb.) is significant at 5% (Sig. Diff. 5% = 94)].

This finding is of some interest. Experiments made in the same year at Kontagora, where nitrogen deficiency is more pronounced than at Samaru, indicated that soluble calcium (gypsum)) had a pronounced stimulatory effect on nitrogen fixation. Experiments to find an optimum calcium/phosphate balance have been made during the present year at a number of stations. The practical significance is obvious. For groundnut production single superphosphate must be preferred to triple super or ammonium phosphate unless a suitable source of gypsum can be found locally. We are advised by the Director of Geological Surveys that such an event is unlikely ; lime applied to the soil or to foliage has not produced the effect shown by gypsum.

With sorghum single super appears to have no direct advantage over triple super ; ammonium phosphate has the most immediate effect. But an important consideration in manuring guineacorn is the residual effect which will be passed to the groundnuts which are usually grown in the succeeding year. Hence it would seem advisable to adhere to single super or single super containing a small amount of added nitrogen.

TYPE OF PELLET.

(i) *High-pressure : various : no bonding material.*—Pellets of pharmaceutical type made at stamping pressures of up to 30 tons per sq. inch. Monammonium phosphate and triple super left no residue at Samaru (rainfall 35 ins.), but an irregular shaped residue, 21 per cent of the original weight, was recovered at the end of the season from triple super pellets used in N. Katsina (rainfall 27 ins.). Single superphosphate, tried in 1948 in Samaru only, left a friable residue, 53 per cent of the original weight. Only traces of soluble phosphate remained in any of the residues. Bone phosphate pellets remained unchanged in shape and the recoverable residue at Samaru was 85 per cent of the original weight.

(ii) *Superphosphate: bonded with graphite.*—The pellets retained their shape throughout the season and gave residues ranging from 45 per cent at Samaru to 70 per cent in N. Katsina ; the residues contained only small amounts of soluble phosphate. Although these pellets contained the equivalent of only 9 lb. P2 05 per acre they gave a better performance than triple pellets yielding 11 lb. P2 05 per acre.

(iii) *Superphosphate : cake : low-pressure.*—Whilst the partial solubility of single super pellets appears not to detract from their immediate performance it is desirable that they shall disintegrate as completely as possible if a well distributed residual (calcium ?) effect is to be obtained. The

recovery of apparently unchanged pellets by the farmer has had a disturbing effect; he has assumed either that his application has been too lavish or that the pellets contain material unacceptable to the plant.

It was found that pellets rolled at hand-pressure from a superphosphate-water dough withstood handling well and broke down in water much more rapidly than the high-pressure pellets. One ton of low-pressure tablets was made for comparative trial with high-pressure pellets during the present year. They were made in the shape of 5" cakes milled so that they would break into 100 square tablets. It was thought that the issue of fertilizers in units which the farmer could recognize (one cake to cost 1d.) might reduce the chances of misappropriation during distribution. The local manufacture of cakes of this sort has possibilities; they are comparatively fragile and the cost of effective packaging might prohibit their manufacture overseas.

(iv) *Pills*: *Granules*.—It has from the outset been difficult to obtain a firm estimate of the cost of pelleting fertilizers in large quantities. Two leading fertilizer manufacturers in the first place agreed that for orders of 1,000 tons or more the cost would probably be in the region of £8 per ton. This was accepted as a reasonable charge for the convenience of distribution and utilization in the early years of issue to farmers: at the same time it appeared that an equivalent type of pill could be made more cheaply locally. The milled cakes referred to above were made by hand-stamping at a cost of £7 per ton: this charge could greatly be reduced by the use of primitive machinery and would be even less if single pills or tablets were made. It has therefore been disappointing that the only quotation yet received for the conversion of 5,000 tons of superphosphate into stamped pellets is £20 per ton, a cost which would place pellets of this kind out of the farmer's reach.

It seems that the cheapest material available commercially will prove to be spherical pills prepared by a process similar to that used in making granules, provided that not too large a pill is required. Experiments are now being made in the production of pills of single superphosphate half the weight of the stamped pellets (1.4 gm.) previously tried: two of these pills will be used per stand.

METHODS OF PLACEMENT: GROUNDNUTS.

(i) *Random*.—It was assumed that in peasant practice the easiest procedure would be to drop two seeds and one pellet together into the planting-hold, afterwards earthing over with the foot. Spacings likely to arise from this practice were tested. It was found that direct lateral contact of seed and spherical pills led either to inhibition of germination (ammonium phosphate 9 lb. P_2O_5 per acre: triple and single super 18 lb. P_2O_5 per acre) or retardation of early growth (triple and single super 9 lb. P_2O_5 per acre): a lateral separation of ½" was found safe. On dropping two seeds and one pellet from knee-height 12 per cent of the seeds fell within ½" of the pills.

Similar results were obtained in field trials with pellets (11 lb. P_2O_5 per acre). Pellets placed in the same horizontal plane as the seed gave equally high increases in yield whether separated by ½" or 1½" from the seed. Where two seeds and one pellet were dropped together into the planting-hole stand-counts made on the ninth day showed a significant germination lag due to both single and triple super (Percentage germination: No Manure = 88.9: Bone phosphate = 88.6: Single super = 78.6: triple super = 76.4. Sig. Diff. 1% = 9.0). Although in this trial both triple and single super after normal supplying gave a significant increments in kernel yield. [+ 152 lb. (sig. 5%) and + 253 lb. per acre (sig. 1%) respectively, allowing 5 lb. seed for extra supplies needed over no manure. (yield 811 lb.)], it was felt that random placement could not be recommended to the farmer. It is, however, possible that this is the only method he will readily adopt, and experiments are therefore being made to find the effect of direct contact of half-size (0.7 gm.) pills and seed and to deter-

mine the distribution resulting from the dropping of two pills and two seeds into the same hole.

(ii) *Toe and Heel.*—By first dropping the pellet and lightly earthing over before dropping the seed it was found easy to avoid contact between the two. The method recommended for the 1948 demonstrations was :—

(*a*) hole scraped with bunched toes ;

(*b*) pellet dropped into hole and lightly earthed over ;

(*c*) pellet trodden downwards and forwards by ball of heel, leaving a heel-mark slightly behind the pellet ;

(*d*) seeds planted in heel-mark, earthed-over and trodden down.

This method offered fair precision, only 2 per cent of seeds falling within ½" of the pellet. In field trials it gave increased yields equal to those obtained by accurately dibbling the seed 1½" from the pellet. Thus the mean increase in kernel yield per acre due to pellets of bone phosphate, single super, triple super and ammonium phosphate (Table II) was :—

Dibbling = + 234 lb. : Toe and heel = + 280 lb.

In practice it was found convenient for one person to drop the pill and for a second to plant the seed in the heel-mark made by the first. Farmers who tried this method in 1948 were almost unanimous in its condemnation. There is a peak demand for labour at the time of planting groundnuts which closely follows the planting of grain crops and coincides with their first weeding, or in bad years with their replanting : there was a just complaint that two lots of groundnuts might have been planted in the time taken to plant seed and pellet separately.

(iii) *Dibbling.*—The use of a spacing dibbler had previously been advocated in Kano Province to encourage close-planting and to reduce bird damage. A 3-pronged dibbler which makes a pellet hold 1½" behind the seed-hole and a second planting-hole 9" ahead of it has proved useful on moist soils ; a modification which allows for the placement of one pellet centrally between two seeds has been used in seed-pellet spacing trials. Dibbling involves one operation more than the "toe and heel" method and is not likely to find favour with the farmer.

(iv) *Dibbling Pellet with Seedling.*—In most districts farmers inspect their groundnut farms and supply vacancies soon after germination. It was everywhere urged by farmers who tried out pellets in 1948 that this would be the proper time to apply pellets to groundnuts. A number of pot experiments had indicated that groundnuts make much later response to superphosphate than do sorghum or cotton and in 1948 it was shown in a field trial at Samaru that single superphosphate powder and triple super pellets gave the same increases in yield whether applied 10, 20, 30, and 40 days after planting. [Mean response to both fertilizers : 10 days = + 371 lb. : 40 days = + 395 lb.: No Manure = 844 lb. kernels per acre].

With the seedling in sight fairly accurate placement is possible. From Bornu, where only one seed is normally used per stand and vacancies in a poor season may be high, it was pointed out that the manuring of seedling rather than seed would lead to a saving in pellets. Accordingly in this year's trials the farmer has been advised to push a pellet into the ground, to a depth of one inch, between one and two inches from the young seedling. Returns from farms so treated are not yet available, but the method has given excellent results at Samaru where it was made standard practice in this year's pellet trials.

SORGHUM.

The same method has been adopted in farmers' trials with sorghum, with which, however, there are indications that an early phosphate effect is of much more importance than with groundnuts. No records are yet available to show the effect of the time of application of pellets on grain yields ; a field experiment made during the present year failed as a result of insect damage to

young seedlings. From pot experiments it appears unlikely that plants manured 20 days after sowing are likely to catch up plants manured at the seed stage, e.g.

TABLE III.

Wet Wts. (gm.) 12 plants Guineacorn (fara-fara) at 37 days. Treated with pellets of single super and monammonium phosphate giving 11 lb. P_2O_5 per acre at : (1) = planting : (2) = 10 days later than (1) : (3) = 10 days later than (2).

			Diff.
No Manure ...		31.3	
Superphosphate ...	1	106.8	+ 75.5
,, ...	2	81.0	+ 47.7
,, ...	3	42.7	+ 11.4
Amm. Phosphate .	1	195.7	+ 164.4
,, ...	2	182.4	+ 151.1
,, ...	3	97.8	+ 66.5
Sig. Diff.	1% = 70.2		
	5% = 52.1		

Owing to uncertainty in this year's early rains, which in some areas caused sorghum to be replanted twice, the farmer has had less spare time than usual and there has been complaint that dibbling pellets around the seedlings is too laborious. Using pellets designed for groundnuts (9″ spacing) 4 pellets are needed for a normal stand of sorghum (3′ spacing); over-meticulous placement by demonstrators has probably exaggerated the labour required.

1950 PROGRAMME.

There is little doubt that with sorghum random placement of pellet and seed will prove safe, and it is hoped to find before the coming season a reduced size of pellet which will prove safe with groundnuts. Negotiations are now proceeding for the manufacture of 800 tons of pelleted superphosphate for free issue in 1950, as the first step in an approved scheme which provides for the free issue of 1,000 tons of superphosphate per annum in each of five successive years. The sponsors of the scheme feel confident that at the end of this period farmers will, after repeated demonstrations of its value, be freely buying superphosphate in quantities commensurate with the phosphate now exported in the groundnut crop. The present local practice of growing groundnuts without manure after a manured grain crop appears to be a sound one, and it is probable that the best use to which fertilizers can be put is to apply them to the grain-crop, leaving groundnuts to exercise their proved capacity for picking up a residual effect. If this practice is followed we may safely expect increased groundnut production to be achieved without detriment to grain production and without making further demand on land reserves.

[Paper read by Mr. M. Greenwood, O.B.E., Assistant Director of Agriculture (Experiments), Agricultural Department, Nigeria, at the Third Meeting of the International West African Conference held at Ibadan, Nigeria, December, 1949.]

REFERENCES.

(1) Hartley, K. T., Emp. J. Expt. Agric. J. 254 (1937).
(2) Greenwood, M., Comm. Bur. Soil Sci., Tech. Comm. 46. 170 (1948).

KWONG TIY & COMPANY LIMITED

REGISTERED OFFICE : **CUMMING ST., SUVA, FIJI**

P.O. BOX 89

GENERAL MERCHANTS & COPRA EXPORTERS

Cable & Tel.: "KWONGTIY," Suva. Codes: Bentley's ABC 5th Ed. & Duo

INSECTICIDAL CEMENT PAINT

NEW TECHNIQUE FOR THE CONTROL OF FLIES AND MOSQUITOES

The development of the synthetic insecticides during the last five years has produced new conceptions of pest control, one of the most important being the application of residual sprays and emulsions for the control of flies and mosquitoes.

Recently a new and promising alternative has become available with the development of the insecticidal cement paint incorporating either D.D.T. or Gammexane (B.H.C.). The writer has been commissioned to carry out experiments over a period of nearly three years and under conditions approximating as closely as possible to temperate, sub-tropical and tropical climates. The tests were carried out on painted asbestos tiles submitted by the manufacturers of the (Anti-Pest) cement paint, the Permacem Paint Company Limited, of Reading, England, and the first series incorporated D.D.T. as the toxic agent. The tiles were exposed to the Blow Fly, the House Fly, the Clothes Moth and the Yellow Fever Mosquito one week after they had been painted, and thereafter at intervals of two months, six months, nine months and one year.

At one week old the tiles were knocking-down Blow Flies and House Flies after 30 minutes exposure, Yellow Fever Mosquitoes in one hour and Clothes Moths within two hours.

The final figures at the end of 12 months proved that mosquitoes were knocked-down after eight hours' exposure and the other insects after 18-24 hours.

It was then decided to subject the panels to a rejuvenation experiment in order to ascertain whether the toxic effect could be revived by cleaning the surface. The tiles were treated in various ways :—

(*a*) Scrubbed with soap and a soft nail brush.

(*b*) Scrubbed with Vim and a soft nail brush.

(*c*) Lightly cleaned with medium glass-paper.

(*d*) An original unused tile which had been kept wrapped at room temperature for 15 months was also exposed without rubbing.

The results were most interesting and can best be shown by the following table :—

100 PER CENT KNOCK-DOWN.

Tile.	Blow flies.	House flies.	Clothes moths.
a.	8 hours.	8 hours.	24 hours.
b.	8 hours.	8 hours.	18 hours.
c.	2 hours.	2 hours.	18 hours.
d.	2 hours.	2 hours.	18 hours.

Tests were then carried out using Gammexane B.H.C. as the toxic agent, with the object of ascertaining whether an anti-pest cement paint could be produced which would be effective against D.D.T.—resistant flies and mosquitoes.

In these experiments a different technique was followed, with the idea of finding out the minimum period of contact with the painted surface necessary to kill the various test insects.

The minimum exposure was found to be five minutes, and under tropical conditions (92°F. 75 per cent R.H.) all the house flies were accounted for in 40 minutes and the mosquitoes in 25 minutes.

The figures for a 10-minute exposure to the paint were very much better ; all house flies were down in 25 minutes and all mosquitoes were on their backs in 15 minutes.

A second test was carried out six months later, using the same tiles but, in addition to the laboratory strain of house fly, an imported strain of typical house flies from Ceylon (*Musca sorbens*) was obtained.

The results after 10 minutes' exposure to the tiles under tropical conditions showed that all flies were knocked-down in two hours.

Mosquitoes at the 6-months' period were all knocked-down in 55 minutes.

The final experiments were confined to a comparison of Permacem D.D.T. and Permacem B.H.C. Cement Paints against the Yellow Fever Mosquito. The results tabulated below were achieved, showing marked advantage in favour of B.H.C. type.

If full-scale field trials bear out laboratory results this type of cement paint will be a useful weapon against these pests. The writer understands that such field trials are to be carried out in Ceylon under the supervision of Dr. L. Kahawita, of the Ceylon Government.

Throughout the experiments the term "knock-down" indicates that the insects were seriously affected and unable to co-ordinate their movements. None of the insects recovered, and there was a 100 per cent mortality of all recorded as knocked-down, although death might occur some time later.

All experiments had controls, and in every case these controls were alive and well throughout.

PERMACEM D.D.T. AND B.H.C. CEMENT PAINTS v. YELLOW FEVER MOSQUITO.

D.D.T. new surface 15 minutes exposure —100 per cent knock-down in 3 hours.

B.H.C. new surface 5 minutes exposure—100 per cent knock-down in 1½ hours.

D.D.T. 3 months old 15 minutes exposure —very poor.

B.H.C. 3 months old 5 minutes exposure—100 per cent knock-down in 1½ hours.

B.H.C. 8 months old 15 minutes exposure—100 per cent knock-down in 3 hours.

(Extract from *New Commonwealth*, Vol. 21, No. 7 (1951), p. 557. Article by F. G. Sarel Whitfield, D.I.C., F.R.E.S.).

The BRISTOL "20" Tractor

This tractor has established its reputation as the tractor with the greatest draw-bar pull for its weight and size of any in the world. The tractor that will pull and keep on pulling on all soils in all weathers under conditions which will defy any wheeled tractor.

Features:

Unit-attached Implements—including the plough with hydraulic lift
Slow-running engine developing 22 B.H.P. at 1,500 r.p.m.
Patent furrow-width control. Longer track units
Power take-off. Full power on turns
Finger-light clutch-brake steering
Weight 3,000 lbs.

THE FIJI TRADING CO. LTD.
SUVA, FIJI **PHONE 631**

PROSPECTS FOR COLONIAL AGRICULTURE

Agriculture is *the* industry in the Colonies and its efficiency is as vital to them as the efficiency of the textile, the motor-car, engineering or any other heavy industry is to us. Colonial development now and for many years to come means agricultural development—and particularly the development of good farming by the indigenous people. The diamond fields of Tanganyika, the copper mines of Northern Rhodesia, the tin fields of Malaya and Nigeria, and the gold mines of the Gold Coast are important, but they only influence the lives of a very small percentage of the 60,000,000 people of the Colonies. Well over 90 per cent of these must follow agriculture as a way of life.

MERE SUBSISTENCE—OR CIVILIZED EXISTENCE ?

But this way of life can mean two things : it can be mere subsistence agriculture with the father of the household doing a bit of heavy work such as bush clearing and breaking new land and leaving his wife, or in many cases wives, to plant and to sow and to reap and to mow and to cook—as is the common practice still with a large proportion of the colonial people. Or it can mean a life in which the people have the help of the machine, the use of fertilisers and modern techniques to raise a full crop ; in which they can enjoy all the amenities of a modern civilized existence with the motor-car, the wireless and the refrigerator and the good home such as we see in present-day farming in this country.

But what are the conditions of peasant farming in the Colonies on which we have to build ? Let me take only four points : man-power, soil, water and capital. First man-power. It is a fact the people with the best health have also the highest productivity per head. How does the peasant farmer in the Colonies measure up to this ? Not very well. He suffers from debilitating diseases such as malaria, hookworm, venereal diseases and in general has a life-expectancy of less than half of that of the western world. In addition he has an unbalanced diet—heavy starchy foods and lack of high-grade proteins. Before he can be expected to do the work a good farmer needs to do, he must get used to foods which build up strength and resistance to disease—and be led also to grow them. This takes persuasion and therefore time. Then in many cases the colonial peasant farmer suffers an annual hunger period between harvests, and it is during this period that he has to work hardest. All this means inefficiency, lack of energy, incapacity which amounts to lack of man-power.

Then the problem of the soil. It is quite untrue that tropical soils are storehouses of fertility and only need tickling with the hoe to make them laugh with corn. Many of the soils of the tropics are very old and in the process of weathering high rainfall has washed out the valuable nutritive elements from the topsoil. So we often get the paradox of luxuriant tree growth on an apparently infertile topsoil. Under shifting cultivation the peasant farmer cashes in on the fertility of the shallow topsoil for two or three years, uses it up and then moves on, leaving the soil to recuperate under bush fallow. So for long periods large areas of land are out of use. In the country of Northern Rhodesia, for instance, ten acres of orchard bush are lopped and felled and piled up and burnt on one acre in order to grow crops of finger millet for two or three years. What a contrast in human effort compared with our breaking up of a three-year grass ley in this country ! There are other pressures on the soil too—erosion, which is made much worse by using additional land for the growing of crops for sale as well as his food crops, and, again, tsetse fly which makes whole areas uninhabitable.

What about water—water for crops and for human and stock needs ? Even in areas of reasonable rainfall there is often a lack of ground water and this is another reason for

the millions of acres of uninhabited, uncultivated land in the Colonies, particularly in Africa. Even in settled areas there may be a daily journey of two or three miles for the wife in order to get three or four gallons of dirty, muddy water from a water-hole, and it is not uncommon to find that cattle are watered every second day, because of lack of natural surface water supplies. For, apart from the relatively narrow equatorial belt with its two rainy seasons a year, the tropics have only one rainy season of four to six months followed by a complete dry season for the rest of the year. And, with the axe, the cutlass and the hoe as their only tools, the majority of peasant farmers have got to wait until the first heavy rains have softened up the land before they can cultivate it for crops. Irrigation water has a very high value. I was told in Cyprus the other day of a potato grower who paid £25 for the right to irrigation water for one acre of potatoes for one crop.

Now for capital. You will have gathered from what I have said that the peasant farmer's capital is mostly limited to the primitive tools which he and his ancestors used for subsistence farming, and here we come to the crux of the problem. So far we have been trying to develop peasant farming without radically altering the traditional system—that is, we have tried to improve the crops which he raised to feed himself and have taught him to add to them other crops which he could sell—cash crops they are called—such as cotton, oil seeds, cocoa, etc. But we are getting nowhere with this. In many cases, by bringing more ground under cultivation in order to convert from a subsistence to a cash economy, we have increased the pressure on the land. The population has grown, but so has soil erosion, and the fertility of the soil has gone down. In Uganda, where cotton was introduced, for instance, 1,500,000 acres have been added to its annual cultivation in the last fifty years, but little more food is produced, while on the other hand the population has risen because of the improved health measures we introduced.

Then there is the question of cattle. The vet. with his vaccines and serums and now with the new drug antrycide, has dramatically reduced cattle disease, but already the livestock is overgrazing the grass which anchors the top-soil—and there we are back to erosion again. In this question of cattle we are up against custom. Too many cattle owners still regard their beasts as a sign of wealth and refuse to sell or even to kill them. So the cattle are eating them off the land and what might be a means of making them richer is leading to poverty and starvation.

Those are some of the problems. Agriculture in the Colonies means a collection of individuals in a community, each of whom—at best—is raising sufficient only for his own needs; it is under-capitalized, unorganized, with no regular pattern of land use or knowledge of how to get the maximum wealth out of the land. Yet it is to farmers of these territories that we seem to be looking now to supply us with food and raw materials on a much greater scale.

REORGANIZING THE PATTERN OF LAND USE.

Can modern agriculture be built on such a foundation? The answer is definitely no. We can and we do patch it here and there with unco-ordinated anti-erosion measures and improve it by distributing good strains of crops and livestock. We can help by establishing water supplies—dams, wells, and bore-holes. Indeed, more money has been poured out by the British tax-payer in the colonial development and welfare grants for agriculture—and particularly to supply water—than on anything else. But we cannot modernize colonial peasant farming and bring it into line with western agriculture by these methods. If we want to increase production so as to feed the people and build up this basic industry, we must reorganize the pattern of land use, and this reorganization must begin at the village level. It is not so much a national agricultural policy which is required; we must combine all the independent elements in an existing village community into a

stable compound, capable of standing the increasing strain of the impact of western civilization.

The biggest problem in the Colonies to-day is to demonstrate that by re-organization, by grouping of the peasant farmers, by the development of a better land use policy, peasant agriculture can use and can give a return on capital investment. In place of the present untidy village lands we want to see the village lands so organized that they are used to the best advantage : the shallow soils of the ridge-tops and the very steep slopes under timber for the needs of the villagers for fuel and building materials ; the gentle hillside slopes strip-cropped with the individual holdings enlarged and grouped and farmed on a common rotation so as to make possible the use of tractors and modern equipment ; the fertility maintained by grass leys and the valley bottoms reclaimed. And with it all a development of specialization within the community so that we get the village tractor-driver, the village herdsman, the village miller, etc. In short we need the development of a village community not markedly different from that which we knew in this country thirty or forty years ago. But all this involves us in problems of land tenure, and land use and the training of specialist workers, and cannot be rushed.

We cannot quickly get rid of old established systems of land tenure and land use. In most cases they are centred round the conception of land as the property of the community with the control of rights vested in the head of the local family group or the clan. These systems are the most important thing in the lives of the peasant agriculturist in the Colonies. And we must take the people with us, and pay most careful attention to their social structure, if we want to succeed. I remember some ten years ago attempting to establish an area as a demonstration of proper land use on a village basis. We planned to check the erosion with strip cropping, to re-group the holdings and homes, to plant up village fuel areas and bring back the fertility of the dying land by organized rotational growing of crops and grazing. It was all discussed with the local Chief, and inducements were offered in the shape of a village pump, a school, a dispensary and such like. The Chief, as a good Civil Servant should be, was enthusiastic, but not so the people. Beneath the veneer of a super-imposed up-to-dateness there remained the age-old kinship group system, and the head of this group—an old man with very few clothes, but with considerable natural dignity—had to be convinced of our good faith before we made any progress. After a long discussion on the top of a rocky hill beneath which spread out the four square miles of his village lands, we convinced him that we had no ulterior motives, that we meant well and that our ideas, although new-fangled, were reasonable and worth trying. From that time the project went ahead. But all this took time and we could not have brought it off if we had not known something about the fears and prejudices so natural to these people who had long had a social structure which in times past had worked well enough.

If we want to develop the Colonies, we need above all to bring together all the facts that we know—social, agricultural and economic—and, indeed, we know a good deal. We want to synthesize what we know so as to make patterns of social and agricultural development in village communities. We must lay down demonstration and research pilot projects to establish the economy of group farming and rational land use. We must find out how best to inject capital—whether in the shape of soil conservation works, water supplies, food stores, drainage, housing, or in tractors and implements. It will take time to get this new pattern established and even more time to sell the finished article to the Colonial people. But I believe after a score of years in the field that, unless we have capital investment in peasant agriculture—all the groundnut schemes in the world, all the large-scale production schemes with their expensive tractors and equipment—will have little effect in raising the standard of living of the peasant farmer in the Colonies, and until we have raised his standard of living and his standard of efficiency the Colonies

will neither produce wealth for themselves nor be effective producers for the rest of the world.

In these days, because of world needs, we are all impressed with a sense of urgency, but in the re-organization of peasant agriculture in the Colonies let us remember that British agriculture has taken a thousand years to evolve from the hillside cultivation of the early Briton, remains of which can still be seen on air photographs of some of the Down country, to the diversified, specialized, highly capitalized industry as we know it to-day.

And although it will take time I am not one of the Jonahs who believe that we have lost the race and that the fertility of the Colonies is declining and that ultimately they will be importers rather than exporters of foodstuffs. I know of no better tonic for this mood than to fly over some of our Colonies and see what can be accomplished by capital investment in colonial agriculture : to see the beauty produced from ugliness, the tidiness from the untidiness of nature, the wealth produced from soil when one approaches the tea estate of Kenya or Nyasaland, the sugar estates of the West Indies, the sisal estates of Tanganyika, the beautiful pattern of a developing countryside which unfolds in flying over the highlands of Kenya. And to me at least it is an inspiration to see the isolated government experiment station amidst a jigsaw of small native farms which it serves, showing them how yields of crops and performance of livestock can be raised beyond anything they knew before.

Finally, I want to say this. Without this new approach to colonial agricultural development we leave the people of the Colonies as anachronistic societies, dependent upon the goodwill and beneficence of the wealthier highly-developed countries of the world, unable to reach the political and social advancement for which the thinking people in the Colonies are increasingly impatient. Colonial development and welfare grants cannot be a permanent means of assisting the Colonies to a higher standard of life ; they cannot be used as poor relief. They are only the catalysts necessary to start off a chain of reactions which lead to continuing development—to an expanded economy. And the political and social advance of the Colonies can only safely be built upon an expanded economy.

(B.B.C. Broadcast by Mr. G. F. Clay, Agricultural Adviser to the Secretary of States for the Colonies.)

RICE VARIETIES : A CORRECTION

Overseas readers should note that it has recently been discovered that the varieties BG 75 and BG 79 appear to have been interchanged several years ago at the time of their first introduction to Fiji. Owing to the confusion that would arise it is not proposed to attempt to correct this error within Fiji but overseas readers should be aware of it and adjust their records accordingly.—Ed.

1948 REPRINT. PRICE : ONE SHILLING.

GARDENING NOTES.

Includes notes on INSECT PEST CONTROL and PLANT DISEASES.

AVAILABLE AT THE GOVERNMENT PRINTING AND STATIONERY DEPT., SUVA.

LOCAL BANANAS BLIGHTED

The banana business in Hawaii is threatened. Bluefield bananas,* Hawaii's most important variety, are extremely susceptible to the widespread and destructive disease known as Panama Wilt. Banana growers have, on numerous occasions, expressed alarm at spread of the disease here and have asked various agricultural agencies to take positive steps to provide relief from it by introducing resistant varieties or by developing control measures through breeding and other researches.

On March 9 the Industrial Research Advisory Council approved a $6,000 grant to the University of Hawaii agricultural experiment station for a project entitled "Introduction of bananas and such other plants from the Caribbean region as may have potential economic value to Hawaii."

Sometime before April 15 the University will send a plant pathologist and a horticulturist to such parts of the Caribbean area as Panama, Central America and Guatemala to carefully examine disease resistant varieties and supervise shipment of samples to Hawaii. The samples will be kept in quarantine for six months with the HSPA experiment station co-operating on this portion of the project. Then, adequate rootstock will be available to any one in the territory desiring to make plantings.

The project will also encompass the papaya, passion fruit, nuts and ornamentals. The University is contributing $1,982 to the project.

Honolulu Advertiser, March 27, 1951.

* Bluefield is known in Fiji as Gros Michel.